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ABSTRACT

A study was conducted for the purpose of clarifying decision alternatives concerning computer-assisted instruction (CAI) in the Merrill Library at Utah State University. The main research questions were: (1) To what extent is the CAI system in use at present? (2) What factors have encouraged or hindered CAI usage? (3) How do people feel about the system? (4) What alternative approaches are available and how feasible are they? To obtain answers to these questions a series of four questionnaires were used to poll students, library staff, faculty users, and prospective users. With the exception of a portion of the library staff, feelings expressed about the CAI system were generally positive. Negative feelings encountered were due to mechanical difficulties. The interview sessions are summarized; the results of a cost-effectiveness study are presented; and recommendations are made for future CAI use at Merrill Library. It is concluded that the CAI system appears to have considerable support from users and is in a position--through anticipated expansion of terminal usage--to demonstrate a level of operation that is more cost-efficient than has previously been the case. A simplified glossary for CAI, a brief bibliography, and the questionnaires used in the study conclude the report. (Author/KKC)

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Instructional Development

An Evaluation of Computer Assisted Instruction in the Merrill Library

utah state university

IR 002 590

AN EVALUATION OF COMPUTER ASSISTED INSTRUCTION IN THE MERRILL LIBRARY AT UTAH STATE UNIVERSITY

by

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January 15, 1975

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I. ABSTRACT

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Computer assisted instruction offers an individualized, self-paced learning mode with potential cost-efficiency	1
Terminals in the Merrill Library were purchased in the summer of 1972 as a demonstration project, and have been used mainly for Computer Assisted Testing (CAT)	2
Initially, more problems with equipment breakdowns were encountered than had been anticipated, but reliability has improved considerably	4
Financial arrangements for use of the terminals have been arranged to maximize the appeal to users	5
This study involved structured interviews with students, library staff, faculty users, and potential users, asking questions about (1) the extent of CAI use; (2) factors encouraging or hindering CAI use; (3) how people feel about the system; and (4) possible alternative approaches	7
With the exception of a portion of the library staff, feelings expressed about the CAI system were generally positive. Negative feelings encountered were due to mechanical difficulties	10
The level of usage of the MLLRP terminals prior to fall quarter 1974 was low, mainly used by a single professor. Since fall quarter, a number of other users have developed and implemented programs	11
A number of factors encouraging CAI use were noted, particularly the self-paced nature of instruction, the novelty of the approach, and the flexibility in scheduling	12
Mechanical complaints were clearly the major factor discouraging CAI use, although some additional factors were cited	13
Many suggested improvements follow from the factors discouraging use, such as (1) upgrade mechanical reliability; (2) simplify instructions to students; (3) offer a workshop for potential faculty users	13
Some additional suggestions were considered noteworthy, e.g. (1) run an independent telephone line to eliminate monthly charges; (2) use the present administrative terminals for CAI on a shared time basis	14

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Cost-benefit calculations give an estimate of efficiency, but do not answer questions about the social value of expenditure or the distribution of benefits 16

Calculations attempted to provide an estimate of costs in the low to moderate range, on a monthly basis 17

With the previous limited level of usage, costs per student session on the terminal are considerably more than the hypothetical use of individual tutors would be 21

However, with the anticipated program expansion for winter quarter, costs per student session for the CAI terminals are roughly equivalent to the hypothetical tutorial model, with possible further cost reductions if student usage were increased 21

Six recommendations for CAI operation resulting from this study are as follows: (1) set up a clear maintenance agreement; (2) expand usage of present terminals by increasing the numbers of student and faculty users; (3) conduct a feasibility study installation of a university-owned computer line; (4) relocate the library's teletype terminal to allow its use for CAI; (4) continue efforts to simplify operations for students, faculty, and library staff; and (6) set up a simple monitoring system to give information about costs and usage of the system 27

II. FOREWORD

Computer assisted instruction (CAI) was begun at the Merrill Library at Utah State University in the summer of 1972 with several purposes in mind. CAI represented a new direction in instructional media which offered considerable promise in individualizing student learning and in maximizing the time and efforts of teachers. The promise of the system was such that this type of instruction was judged too important to ignore. Rather than invest heavily in CAI, however, an attempt was made to try the system at a low level before expanding. First one terminal and later two more were purchased.

This report examines the present level of operation, first from the viewpoint of those familiar with CAI operation and then from the standpoint of efficiency, through cost-benefit analysis. Appreciation is expressed to all those who responded to interviews or who took time to provide needed data for this report. The conclusions and recommendations are those of the author, and he assumes full responsibility for their accuracy. It is hoped that this report can be of use to those connected with the program in deciding upon direction and level of operation for the future.

J. N. Eastmond, Jr.
December 23, 1974

III. DESCRIPTION OF COMPUTER ASSISTED INSTRUCTION OPERATIONS

Using the computer for computational assistance is not new at Utah State University. The computer science department, various engineering departments, and others, have been using the computer for years to speed calculations and to allow for the solution of complex problems. However, the idea of using the computer as a substitute instructor (or tester) is somewhat newer, and its applications--in conjunction with programmed instruction, individualized, and self-paced learning models--are still being explored.

Arguments For CAI

Education has been criticized by some observers (e.g. Machlup, 1970) as being locked into a "labor intensive" mode of operation requiring large numbers of highly skilled teachers. One proposed means of increasing efficiency has been to substitute capital for labor; for example, use a computer terminal or media to increase a teacher's ability to instruct, and thereby provide the same or improved learning for less cost. Aside from the economic arguments, advocates of CAI have cited the advantages to be obtained from self pacing of instruction from the immediate feedback and motivational aspects of the computer. In some schools (e.g. the Air Force Academy or Brigham Young University) extensive use is made of CAI, to include entire courses structured around the computer. The quotation from Kenneth Boulding is illustrative of the promise many see from the application of computer technology:

> The computer is an extension of the human mind in the way that a tool or even an automobile is an extension of the human body. The automobile left practically no human institution unchanged as a result of the increase in human mobility which it permitted. The impact of the computer is likely to be just as great, and indeed the whole world of electronic media this represents . . . an extension of the human nervous system and what is perhaps even more important, a linkage of our different nervous systems. (Boulding, 1968, p. 209).

The Terminals In MLLRP

The acquisition of three computer terminals for the Merrill Library and Learning Resources Program (MLLRP) began the CAI program. The first CRT terminal was purchased in May, 1972, with funds from the Instructional Development operating budget, and two additional terminals were acquired later that winter made possible by an allocation from the Provost's office.

The terminals, Beehive Models No. III-A, were purchased from Beehive Medical Electronics Inc., Salt Lake City, Utah. Each of the three terminals closely resemble a television screen with a typewriter keyboard attached. CRT (Cathode Ray Tube) Terminals such as these have the advantages of speed of presentation and good readability. The disadvantage, however, is that the message erases completely and instantaneously, leaving no "hard copy" as a teletype terminal would produce. In order for the student to keep a copy of the material, he has to make written notes. The library does own one teletype terminal but has used it mainly for bibliographic searches and assorted library uses, rather than for CAI or CAT.*

*An explanation of computer terminology used in this report is found in the Glossary on page 29.

The computer terminals were intended to augment the various media and learning modes then available in the library. The terminals were placed in the Audio Visual area of the library, where their operation could be monitored by library personnel. While it was recognized that three terminals did not represent a major commitment to this mode of instruction, it was hoped that: (1) faculty members from various departments could use these centrally located and accessible terminals for purposes that would complement their own courses; (2) programs and expertise with CAI could be developed on campus; and (3) Utah State University would not be completely ignoring a field which appeared to have considerable promise for future growth.

CAI VS. CAT

During the two years of operation in MLLRP, the most frequent use of the computer terminals has been for computer-assisted testing (CAT). Students come to the library at their own convenience to take required quizzes for a class. The computer asks them multiple choice questions covering material they have studied, they enter their answers, and the computer tells them if their response was correct or incorrect as well as supplying the correct response. In addition, the computer records their answer and, at the option of the instructor, gives an item analysis or scores of groups of items demonstrating a particular skill to the instructor. By including several alternative forms of the test, the student who fails to obtain a passing grade can retake the exam at a later time after restudying the material.

Some limited use of computer assisted instruction (CAI) has been made on these terminals, particularly during the fall quarter of 1974. In this mode of operation, the student is given instruction similar

to that encountered in a programmed text. He is asked certain questions dealing with the material presented and must enter his answers, to which he is given immediate confirmation or correction. Computer assisted testing represents an abbreviated form of CAI, where only the questioning mode is used.

Operational Difficulties

Following initial installation of the computer terminal, problems with equipment breakdowns were much more frequent than had been anticipated. A number of reasons for these breakdowns has been suggested, and these will be examined more completely in the Results section below. At this point it should be noted that mechanical difficulties were many and varied; that the process of "debugging" has gradually improved the reliability of the operation; but that operation of the system has not been smooth and routine. Considerable effort has gone into making the operation both simple and reliable, and at the present time the terminals are reported to be relatively trouble-free. Within the past two months, the terminals have been moved to a different section of the library--on the fourth floor with the microfilm, microform, and microfiche readers.

The present provision for service is not under a service agreement. When a terminal malfunctions, a call is placed to the computer center where a programmer/specialist traces down the problem. If the problem involves the program or the main computer, this specialist can handle it. If the problem traces to the telephone line connecting terminal and computer, the Bell Telephone Company repairman is called in. Finally, if the terminal itself is defective, a repairman must be

called up from Salt Lake City or the equipment must be taken to the Salt Lake City office for repair. Real difficulty can result when the exact location of the malfunction is not apparent, because each party involved can maintain that his portion of the system is not responsible for the breakdown. The shared responsibility for maintenance plus the obvious complexity of the system tend to increase the amount of time that the "system is down," i.e. inoperable.

Financial Arrangements

As mentioned above, the initial outlay for the terminals was made with the original purchase. The cost of the operational costs is shared as follows:

1) The cost of the computer line and monthly equipment cost are shared equally by the MLLRP and the Exceptional Child Center.
2) The telephone line cost is paid by the MLLRP.
3) The MLLRP pays for the staff time to monitor CAI operations.
4) The cost of programmer time to set up the initial program is paid by the department or instructor involved.
5) The cost of maintenance, which fluctuates considerably, is shared between the parties involved.

Attraction To Faculty Members

The present system was designed to encourage potential users to become involved with CAI. The purchase price of the terminals has been covered, and the operating budget of MLLRP defrays the major portion of the monthly expense.

Personnel to monitor the operations, as well as an extended day of service, offer potential advantages for users. Costs to the user

are mainly developmental, although some month-to-month operational expense is involved. Reactions of potential users to the system is reported in the "Findings" section below.

IV. PROCEDURES OF THE STUDY

This study was requested in early October with the expressed purpose of clarifying decision alternatives concerning CAI in the Merrill Library. The scope was purposely limited in time and resources to allow quick turnaround of information.

Research Questions

A set of research questions proposed for the study is given in Appendix A. Questions were generally descriptive in nature, the following being the main questions:

1) To what extent is the CAI system in use at present?
2) What factors have encouraged or hindered CAI usage?
3) How do people feel about the system?
4) What alternative approaches are available and how feasible are these?

The Questionnaire

To obtain answers to these questions a series of four questionnaires was used to poll students, library staff, faculty users, and prospective users. Following a brief pilot testing, students and prospective faculty users were polled with a telephone interview, while for library staff and present faculty users a structured interview was used. The standard questions asked each group are given in Appendix B. Additional questions were asked if the interviewer felt that useful information could be obtained.

The numbers of persons interviewed were purposely kept small: students--four; library staff--six; potential faculty users--four; and present faculty users--four. To these eighteen people who were formally interviewed must be added at least four additional people who were helpful in supplying data or ideas for the study.

Faculty and staff to be interviewed were selected on the basis of familiarity or interest in the CAI operations, as recommended by Dr. Douglas Alder, Associate Director of the Instructional Development Division of the MLLRP and Dr. Max Peterson, Associate Director of the MLLRP. Students were chosen from the class roster of Dr. Robert Mecham taught spring quarter.

Data Distillation

No attempt was made to use statistical procedures to analyze the data obtained in part because of the small number of persons interviewed and in part because of the research questions examined. Rather, the results have been reported as closely to the wording and intent of the original person interviewed. Where a useful observation or suggestion could be gleaned for the report, this has been done. It is recognized that these results have passed through the filter of one observer's interpretation and as such are not objectified in the sense that some inquiries could be.

Cost-Benefit Data

Cost data have been extracted from records of expenditures wherever possible. In many cases, however, where an estimate has been necessary, this has been done using the best informed judgment available. Projections of winter course loads were made by contacting the instructors

involved. The rationale for determining costs and estimating benefits is given in Appendix C of this report.

V. RESULTS

Perhaps the best place to begin in reporting results is by recommending that the reader turn to Appendix B and read some of the responses given. Some real insight into the system's operation from the point of view of students and staff, potential users and present users can be gained.

This section attempts to synthesize the data reported there, to condense the findings relating to the major investigated questions.

Feelings About The System

Expressions of feeling toward the CAI system are generally positive, with skepticism and some fairly strong negative feelings expressed by some persons.

Student response was overwhelmingly positive after the initial hesitation that was reported in learning to work a new machine. Although all but one had experienced some frustration when the machine was out of order, all of these students--in remembering their previous experience, roughly six months previously--expressed good feelings about the system.

Present faculty users were somewhat more aware than potential faculty users of difficulties which can occur, and thus were somewhat more reserved in answering the question of whether they would recommend the system to a colleague. Responses were affirmative, but only if the colleague was judged sufficiently flexible to handle difficulties which could arise. All but one user indicated that a back-up system--

e.g. a paper and pencil quiz--could be made available if the computer were inoperable.

Feelings among library staff toward the CAI operation were mixed. Of the six people interviewed, three expressed strongly negative feelings about the system, one strongly positive, and two somewhat ambivalent, expressing both positive and negative feelings. The recent move of the terminals to the fourth floor of the library has reduced this potential source of conflict to a large extent.

Present Level Of Usage

Within the past three months, there has been a rising level of usage of the MLLRP terminals. Prior to that time, the testing program of Dr. Robert Mecham of the Business Administration Department was virtually the only program in operation. In a class of roughly 50 students, eight quizzes taken at the MLLRP terminal were required during the quarter. Assuming that each student took each quiz one and one-half times, since one retake was allowed with no penalty to the student, roughly six hundred tests were taken each quarter. For most of the quarters since the installation of the terminals, Dr. Mecham's program was the only program being used.

Recently, however, Dr. Rex Hurst, Head of the Computer Science Department, has arranged for two programs in a statistics class and has several other options which he is in the process of putting into operation. Mr. Robert Woolley of the library staff has brought a number of programs into operation and has plans to use them with classes winter quarter. Additional faculty members are anticipating beginning winter quarter.

A strong possibility exists that a second section of the business administration course will be taught using the CAI quizzes as a portion of the class. Others on campus have expressed interest in using the computer terminal for CAI purposes. To what extent faculty members will be able to implement these programs will depend to some extent on the ability of the terminal operation to handle increased numbers of users. The evidence is that, up to this time, the terminals have been underutilized, but that the trend is toward more full usage.

Factors Encouraging CAI Use

Many of the factors cited in the interviews as advantages of computer assisted instruction or testing have been cited already. The provision for students' self-pacing for immediate feedback, and for accessibility during extended hours of the day were seen as advantages for students. For teachers, the system was seen to offer a useful way of eliminating routine tasks for the teacher himself or for his assistant(s). The novelty of the approach was seen as an advantage to both students and faculty as it helped to motivate students and expedite learning. Library personnel saw the system as a useful addition to the library's resources, with at least theoretical or potential value, although in some cases demanding more time than the monitors could afford to give.

Factors Discouraging CAI Use

The comment of one faculty user serves to highlight the major disincentive to the system. After experiencing considerable frustration due to mechanical failure and finally removing his program from use, this person could say, "When the bugs get worked out of the system, I want to know about it so our program can go back into operation."

All persons interviewed were alike in wanting to see the system work smoothly. While it is acknowledged that major improvements have been made in the system's reliability, there is no doubt that the frequent mechanical failures have been the greatest disincentive to CAI use in MLLRP over the past two and one-half years.

Additional disadvantages cited were (1) scheduling problems at peak periods in the quarter--often aggravated by mechanical problems during these times; (2) cost factors which would make the system costly in comparison with other means, e.g. test correction by hand; (3) the problem of students having to leave their department and go to the library to use the terminal; (4) lack of instructor familiarity with complex computer procedures necessary to set up programs; and (5) lack of simple, specific instructions for students and monitoring staff.

Alternative Approaches

Many of the proposed improvements offered by those interviewed follow logically from the disadvantages listed above. Typical suggestions included:

1) Upgrade the mechanical reliability of the system to where malfunctions are the exception rather than commonplace.
2) Use a service agreement; if not from the equipment supplier, then from a local electronics technician, so that there is an incentive to maintain trouble-free service.
3) Make student instructions breathtakingly simple.
4) Following a student response to a question, allow more time for the question to fade (or put under the student's control) so that the question and alternatives may be re-read thoroughly.

5) Provide a training course and a simple operations manual to anyone who will be expected to monitor the system.

6) Simplify the process of bringing the system into operation.

7) Move the terminals out of the library and into the various departments.

8) Offer a workshop to prospective faculty users to explain the process of getting a program operational.

9) Have a simple manual for faculty users to cite programs which are currently available in various fields.

10) Increase the number of terminals.

Some additional suggestions, some very ingenious, do not follow directly from stated deficiencies, but may offer considerable promise:

1) Purchase a "multiplexer" unit to improve the system's speed. The present polling system is not instantaneous and does require additional student time waiting. Extimated cost for this unit is about $4,000, but it would serve terminals other than MLLRP's and cut monthly equipment costs.

2) Put some central campus agency in charge of the proliferation of CAI terminals to coordinate and maximize their use.

3) Obtain a teletype terminal with "hard copy" capability.

4) With the assistance of the Engineering Department, put in a computer line from the MLLRP terminal to the computer. For MLLRP, the conduit already exists, and the saving each month ($91.90 for line and equipment) would be substantial.

5) Use present administrative terminals on a shared time basis for instruction as well.

Other suggestions were given (See Appendix B), but those cited above were judged most worthy of consideration at this time. This particular phase of the interview, eliciting suggestions for improvements, was extremely valuable in enlarging the range of possible solutions to present problems.

VI. A COST-BENEFIT ANALYSIS OF MLLRP TERMINALS

Cost-benefit analysis has been described by Warner (1970) as a substitute for the pressures of the marketplace in a public institutional setting. Cost-benefit offers a rational approach to maximizing return (benefit) based upon efficiency of spending (cost).

Limitations Of Cost-Benefit

In prefacing a cost-benefit analysis, it is important to emphasize some limitations of such a study. Any calculation of costs must necessarily involve some assumptions and estimations. There are a number of formulas which may be used, as well as alternative bases for comparison. For example, a CAI program could be compared with other modes of instruction such as classroom lectures, slide-tape presentations, or typical quiz sections. Another comparison is across program options for the CAI--e.g. expansion, modification, phasing out, etc. Portions of both approaches are attempted herein.

The important thing to emphasize with any cost-benefit analysis, however closely tied to actual data, is that the measure is only one of efficiency. Numerous other factors must be considered in making any decision, such as the distribution of benefit to certain segments of the campus population, the feelings of people involved, and the social value of the project. Thus, it is possible for practitioners in the study of cost-benefit--e.g. Barsby (1972) and Eastmond (1967)--to make recommendations considerably different from those which the cost-benefit model alone would suggest.

This analysis involves the actual monthly costs or the best available estimates which could be obtained. An explanation of each cost computation, actual or estimated, is included in Appendix C. Estimates of costs are generally in the average or low range, simply to allow conclusions that the item costs at least this much. Estimates of benefit have generally been average to favorable.

Assumptions

Certain assumptions are necessary in beginning any cost-benefit analysis. The present ones are as follows:

1) Computer-Assisted Instruction (CAI) and Computer Assisted Testing (CAT) are not distinguished in the calculations.
2) The C.A.T. program of Dr. Robert Mecham, which was virtually the only program in use for most of the two and one-half years of operation of the terminal, is used as the cost-benefit baseline.
3) The CAI terminal could be compared with several different models of learning. However, with the immediate feedback and individualized pace, it appears to fit closest to the tutoring model, and costs are calculated with this comparison in mind.
4) Calculation on a monthly basis (rather than quarterly or annually) is assumed to handle the periodic fluctuations anticipated in the system.

Computation Of Costs

A detailed computation of costs is given in Tables 1 through 3, apportioning costs between MLLRP and the Business Administration Department. Because of the basis for estimates used, while costs could be found to run somewhat higher, it is doubtful that they are any less than the total figure shown. The total cost is computed at slightly over eight hundred dollars ($802.81) per month.

TABLE I

A Calculation of CAI Costs To MLLRP

Note: An explanation of the basis for each figure is given in Appendix C.

	Monthly Cost	
I. Fixed Cost		
A. Initial Expense For Terminals $7,582		
1. Depreciated over 5 years at 6% interest	$146.94	
2. Opportunity cost: interest foregone at 6% simple interest	39.00	
B. Program Development		
1. Cost of mini grant ($300) depreciated over 5 years at 6%	5.80	
2. Opportunity cost: interest foregone at 6% simple interest	1.50	
C. Cost of Floor Space (Estimated) . . .	25.00	
Total Fixed Cost To MLLRP		$218.24
II. Variable Cost		
A. Telephone Line Cost		
1. Monthly equipment cost (shared 50-50 with Exceptional Child Center)	$ 34.40	
2. Computer line (shared 50-50) with Exceptional Child Center) .	57.50	
3. Restricted telephone line	2.50	
B. Maintenance Cost On Hardware, under hypothetical service contract, estimate based upon $20/month per unit	60.00	
C. Personnel Cost (administration cost plus one-fifth time of person monitoring)	300.00	
Variable Cost To MLLRP		$454.40
TOTAL, All Costs To MLLRP per month		$672.64

25

TABLE 2

A Calculation of Monthly CAI Costs To The Business Administration Department

I.	Fixed Cost		
	A. Program Development Costs (estimated $2,000 depreciated over 5 years at 6% interest	$38.67	
	B. Opportunity Cost: interest foregone at 6% simple interest . . .	10.00	
	C. Instructor Time Cost in program development, assumed equivalent to alternative quiz procedure and not calculated	0.00	
	Total Fixed Cost		$48.67
II.	Variable Cost		
	A. Monthly Charge for Computer Use		
	1. Data Storage (estimated)	$15.00	
	2. Computer time in use* (estimated)	26.50	
	B. Computer Specialist To Troubleshoot	40.00	
	Total Variable Cost		$81.50
	GRAND TOTAL, All Costs To Business Administration Department per month		$130.17

*NOTE: A new billing system through the computer center, allowing any run of less than 5 seconds to be billed to a central account, will shift this expense from the Business Department.

TABLE 3

Summary of Calculated Monthly Costs of The CAI Program To MLLRP And The Business Administration Department

I.	Fixed Cost		
	A. To MLLRP	$218.24	
	B. To Business Administration	48.67	
	Total Fixed Cost		$266.91
II.	Variable Cost		
	A. To MLLRP	$454.40	
	B. To Business Administration	81.50	
	Total Variable Cost		$535.90
	GRAND TOTAL, All Costs per month		$802.81

Computation Of Benefits

Benefits are figured as the number of student sessions with the computer during a month's time. Dr. Mecham's class typically has an enrollment of 50 students who take a total of eight quizzes at the CAI terminal during the quarter. Students are allowed to take the quiz a second time without penalty and many of them do so. Assuming that each student takes every other quiz twice, a total of 600 sessions per quarter or 200 per month is thus obtained.

Cost-Benefit Calculation For Previous Operational Level

A calculation of cost-benefit would show:

$$\frac{\text{Costs}}{\text{Benefits}} = \frac{\$802.81/\text{month}}{200 \text{ student sessions/month}} = \$4.01/\text{student session}$$

At the present time, this cost is apportioned at approximately 84 percent to MLLRP and 16 percent to Business Administration. Clearly, this program is expensive at the present level of operation.

A comparison with a hypothetical tutorial model is useful at this point. It is assumed that student tutors could be hired at $3 per hour and used to tutor three students per hour. If additional costs of $1.50 per hour could be assumed to cover (a) administrative overhead; (b) salary fringe benefits; and (c) office or classroom space, the total cost per hour of tutoring would be $4.50. A cost-benefit ratio would show a cost of $1.50 per student session. At the low level of CAI operation, the CAI model is about two and one-half times as expensive as the tutorial model.

Cost-Benefit For Projected Expansion Winter Quarter

However, if the number of students served by the CAI operation is expanded, as projected, the unit costs in the program drop. As was

mentioned earlier, this expansion has begun to take place during fall quarter of this year. For winter quarter, a total of five additional classes are expected to use the CAI terminals. The estimated number of student sessions for winter quarter is calculated as follows:

TABLE 4

Estimated Student Sessions For Winter Quarter

Program	No. of Students	No. of Sessions	Repeat Factor	Total Student Sessions
A: Previous Program	50	8	1.5	600
B	150	7	1.0	1,050
C	70	5	1.0	350
D	25	5	1.2	150
E	12	2	1.0	24
Quarter Total, Student Sessions				2,174
Monthly Total, Student Sessions				725

This expansion is a major one, more than tripling the previous level of usage. For the most part, this is being done with pre-existing programs, or modifications of these. No attempt is made here to calculate the increase in fixed costs, in each case an investment in a computer program, debugging it, etc. However, variable costs will rise, as estimated below:

TABLE 5

Anticipated Increase In Monthly Variable Costs
Due To Expanded Usage

Additional Personnel Cost (increased from one-fifth to two-fifths time, plus administrative costs)	$300

(Table 5, Cont'd)

Additional Computer Data Storage (at twice present level)	$ 30
Additional Computer Time In Use (at $10/month/program)	40
Additional Computer Specialist Time To Troubleshoot (at twice present level)	40
Total Additional Variable Cost Per Month	$410

The major increase in expense is anticipated to be in personnel time involved in monitoring the operation. At least three times as many new students will need to be oriented to the operation. Scheduling will likely be essential to accommodate all students. In short, at least an additional one-fifth of the staff monitor's time will likely be needed.

The calculation of a cost-benefit ratio for an expanded program is as follows:

$$\frac{\text{Cost}}{\text{Benefit}} = \frac{\text{Previous Total Cost + Additional Variable Cost}}{\text{Increased Student Sessions}} = \frac{1212.81}{725} = \$1.67/\text{student session}$$

This ratio approximates much more closely the cost for the tutorial model ($1.50 per session). Further expansion* could likely bring the CAI operation into a position of relative advantage over the tutorial model. However, the feasibility of such expansion with existing equipment has yet to be demonstrated.

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*Dr. Mecham has indicated possible interest of a colleague in Business Administration in possibly using the same quiz program. Other interested potential users were noted in the interviews.

Capacity Of Existing System

A question ought to be raised as to the maximum capacity of the existing system, and whether the proposed expansion will push it to its limits. Assuming an average time of thirty minutes per student session--including explanation time, familiarization, breaks between users, etc.--each terminal could handle two students per hour, a total of nine students per hour. This is a fairly generous time allotment, as many sessions take considerably less than twenty minutes.
With terminals accessible 300 hours per month, a maximum of 1800 student sessions per month is possible in theory. The proposed expansion in usage would utilize 725 student sessions per month. The program would then be utilizing well under fifty percent of the system's capacity (about 40 percent).

While it may be necessary to set up a formal scheduling system and a system of pacing in assignments to prevent end-of-the-quarter overload, winter quarter will not be near the system's capacity. Thus, arguments to bring in additional computer terminals would seem to be premature at this time, particularly in view of the need to demonstrate that cost-efficiency similar to the tutorial model can be attained.

Conclusions

In conclusion, it can be seen that the CAI system has been under-utilized up to the present time. Costs per student session have been relatively high for the CAI terminals up to this point, over $4 per session, due to the relatively small number of students served.
Given the experimental nature of the program, as the pilot project for possible greater utilization, as well as the exposure demonstrated favorable and experience with computer applications given to both

faculty and students, the expenditure can probably be justified. This cost, however, is estimated at more than twice that of a comparable tutorial program. However, if the operation is expanded as anticipated for winter quarter, it is estimated that costs will be more nearly comparable to the tutorial comparison model, but still somewhat higher.

The key to making the CAI terminals cost efficient at this time is seen to be increasing the numbers of faculty members and students using the facility. Given additional expansion, it is anticipated that the CAI system could be made to operate more efficiently than the tutorial system. However, such efficiency has yet to be demonstrated. Given the estimation that the expanded CAI use would still utilize the terminals for about 40 percent of the available time, two conclusions can be drawn.

First, there is considerable room for expansion in the numbers of students and faculty served at this time. Second, any attempts to increase the number of terminals through new acquisitions would seem to be premature at this time.

The question of what the minimum cost per session could be, using the present terminals, is difficult to estimate. Certain economies may be affected, expansion of programs and numbers of students served may be maximized, but only with an increase in variable costs such as monitoring personnel costs, computer expenses, and maintenance. At some point, given the cost constraints described above, cost reduction reaches a limit. For the present system, that limit appears to fall between $.75 and $1 if half-hour sessions for each student are scheduled and between $.50 and $.75 if twenty minute maximum sessions are scheduled (with costs shared by MLLRP, the computer center, and various departments). Such calculations become extremely tenous, being merely

extrapolations of present data; but they do estimate some theoretical limits to efficiency of operation of the present system.

It has been suggested in one of the interviews that CAI may see the kind of cost reduction that has happened with electronic calculators in recent years. If so, it will be a new generation of CAI terminals and programs which will bring this about. At the present time, CAI operation must generally be justified on grounds other than cost efficiency alone.

VII. RECOMMENDATIONS

Based upon the interviews with present and potential faculty users, library staff, and students who are acquainted with the Computer Assisted Instruction program at the Merrill Library and Learning Resources Program (MLLRP), the following major recommendations are offered:

1) Set Up A Clear Maintenance Agreement and definite responsibilities to keep down time minimal for the terminals. If a local technician can be found and service can be set up on a monthly basis, with parts and labor provided as necessary, this would seem to be the most economical approach. Reliability for this system is a must.

2) Expand Usage Of Existing Terminals. There is evidence that a number of potential faculty users of the CAI terminals are available and that the number scheduled for winter quarter will greatly decrease the cost per student of operation to a level comparable but slightly above that of a tutorial model. Considerable enthusiasm for this approach on the part of faculty and students would seem to justify an attempt to expand usage. If all goes well, it can likely be expanded to a fairly favorable cost-efficient position.

3) Conduct A Feasibility Study to see if the fairly substantial line and equipment costs paid to the telephone company can feasibly and legally be reduced by having a line located in existing conduits.

4) Relocate The Library's Teletype Terminal to the CAI area to allow for its use for instruction as well as its present use in bibliographic searches, etc. While some provisions for soundproofing may be required, there appears to be enough interest in a hard copy system to justify making this available for both CAI and library use.

5) Continue Efforts To Simplify Operations, from the standpoint of faculty and student users, as well as from monitoring library staff. For students, this could be a one-page, step-by-step set of instructions. For library monitoring staff, a brief booklet of instructions on what procedures to follow for troublesome situations would be helpful. For faculty members, a booklet on how to select an existing program, how to obtain assistance, etc., could be helpful to them and useful in encouraging others to avail themselves of the service. In any case, simplicity is crucial.

6) Set Up A Simple Monitoring System, giving a record of costs and usage of the terminals, which could be examined at periodic intervals (e.g. every quarter) to compute the relative efficiency of the system.

In conclusion, the CAI system appears to have considerable support from users and is in a position--through anticipated expansion of terminal usage--to demonstrate a level of operation that is more cost-efficient than has previously been the case. It is recommended that this course of action be followed, but that additional purchases of complex hardware or more terminals be avoided until a more cost-efficient level of operation is reached and can be maintained. If such a level cannot be attained, it is recommended that a hard look be taken at the system to see if its benefits justify the operational costs.

VIII. SIMPLIFIED GLOSSARY FOR CAI

Some observers have accused the people who work around computers of speaking a new language. While this is an overstatement, certain terms are often used which may or may not be familiar. Here is an attempt at clarifying.

"Bring up the system"	Putting the terminal into operation through a step-by-step procedure.
C.A.I.	Computer-Assisted Instruction.
C.A.T.	Computer-Assisted Testing.
"Computer is down"	The computer (or terminal) is out of operation.
C.R.T.	Cathode Ray Tube; a particular type of terminal where the message is given on a screen (similar to T.V.).
"Debugging"	Process of correcting errors in a computer program.
"Hard copy"	Message from the computer given on paper.
Hardware	The mechanical parts of the system; the computer, line, and terminals.
"Hot Reader"	Type of terminal where a program (usually small) is fed in and gives the printout immediately. A "self-service" computer.
"Log on"	Putting the terminal into operation through a step-by-step procedure.
Multiplex	A particular way of combining messages from terminals in different locations.
Polling	A method of taking the message from two or more terminals and transmitting it on a single telephone line.
Printout	Same as hard copy. Message from the computer given on paper.
Software	The computer program, the message, the content.
Teletype	Terminal which gives a printout.
Terminal	A unit, similar to a typewriter, through which messages are sent to and received from the computer.

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APPENDICES A, B, C, AND D

TO

AN EVALUATION OF COMPUTER ASSISTED INSTRUCTION IN THE MERRILL LIBRARY AT UTAH STATE UNIVERSITY

by

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APPENDIX A:

Research Questions And Sources Of Data

Proposed For CAI Study

October 21, 1974

RESEARCH QUESTIONS AND SOURCE OF

DATA FOR COMPUTER-ASSISTED INSTRUCTION

Administrative Information

1. To what extent is the CAI system in use at present?

   a. number of terminals
   b. number of departments
   c. number of programs available
   d. number of students affected

2. What are the costs of the system?

   a. initial outlay
   b. of operation
   c. of maintenance
   d. of operator time
   e. to department's use

3. What alternative solution strategies are available?

Records of Operation and Maintenance

1. What is the frequency of CAI use?

2. How much unanticipated down-time?

3. How frequently are repairs necessary?

4. What maintenance expense is incurred?

Questionnaires

1. What types of learners use these facilities most effectively?

2. What evidence is available to support the effectiveness of this system?

3. What advantages does this system have over other systems?

4. How do people learn about the system?

5. What mechanical expertise is required to operate the terminal?

6. Who are the professors and students that avoid this type of instructional mode? What are their reasons?

7. How much operator time is involved in using CAI?

8. What alternative systems are available?

9. How do users and non-users (students, faculty, and library staff) feel about the system?

10. Of students who have used the program, how much frustration was encountered?

APPENDIX B

Research Data From Interviews Of Library Staff, Students, Present and Potential Faculty Users

PART I: LIBRARY STAFF

1. What has been your relation to the computer terminal operation, and how long have you been involved?

   Directing the operation. Two years.

   In my division, but not direct supervision. One and one half years.

   Occasional assisting at the computer users at the counter. Since the beginning of computer operations.

   Program maintenance and simple troubleshooting. At least one year.

   Recently placed in charge of operations. One to two months.

   Monitor operations at the terminal, terminal operator for two years.

2. Has your experience thus far been generally favorable or unfavorable?

   Favorable - 1

   Unfavorable - 3

   Ambivalent - 2 : Program portion all right; but terminal operations unfavorable.

   See many possibilities for uses, but can also see administrative difficulties.

3. What advantages do you see with this mode?

   The system has great library possibilities, particularly as a device to allow the self-motivated student to pursue studies on his own.

   There is considerable flexibility in how the system is used. It offers a full range of media possibilities, with an interactive mode of learning.

   Students enjoy playing with it for the sheer novelty.

   It is good for the ambitious student. For one thing, it offers immediate feedback. For another, it allows the student to retake the test--up to three times with the present program. It is a great saver of secretarial time in giving and scoring the tests.

   The hours are flexible for the student to use the terminal. The cost of paper as well as the slow speed of other alternative models make this system more efficient than a "hard copy" system. Also, it is more reliable.

   An item analysis of questions on the quiz is available to the instructor, to allow him to see which ones were missed most and what misconceptions exist.

In theory, it frees up instructor time. It saves him time in grading papers.

A learning program is best in transferring facts. Material is covered at the learner's own rate. A quiz becomes a learning device.

4. What disadvantages or problems are you aware of?

The system is often unreliable. I think it is a form of "window dressing" to make our programs appear sophisticated by saying that we have CAI.

It seems possible that the system to this point has had inadequate funding, supervision, programming, and training.

The terminal reliability to this point has been questionable. There has been a constant effort in maintaining the system.

Because the recording of scores was unreliable, it was necessary to set up a manual, back-up system which came to be very time consuming for staff.

Staff members at the terminal have been unable to diagnose problems directly when they occur. They have had to depend upon the computer center for support. There is one key person responsible for spotting difficulties; when he is gone, the system breaks down and stays inoperable.

There is a tough communication problem between library staff and computer experts. We speak a different language.

When the main computer goes down, it shuts down our operation, and it is sometimes a long process even finding out what has happened.

The Beehive Company may have been less expensive initially, but one wonders if the supplier is not less reliable than others might have been.

There is a problem with slow response time. A student enters the information and has to wait for the computer to come back with an answer, due to the method of polling now in use.

Personnel at the terminal were already spread too thin with all the other activities required of them. The time cost--for recording scores and monitoring operations--has been high.

There is a problem with any such mechanical operation: the machine is between the student and the instruction.

The need to tie into a computer center that is physically removed from the library operations is a bit of a problem. Attitudes between the two groups have sometimes been less than favorable. Sometimes it appears that the computer people want to be depended upon.

The system is inherently a fixed mode. There are really no variables in the give and take of instruction. It is best suited for programs with very straight-forward subject matter.

5. How much mechanical expertise is needed to handle the operation?

There shouldn't be much needed. It ought to operate like an automobile, where the driver knows how to drive but not fix the machine.

The continual change in operating procedures (estimated 5 or 6 per quarter) kept things complicated.

The need for computer security, and in some cases secrecy, can be tricky.

Good basic instructions for those involved with the computer operations are a must, but the mechanical expertise required is very little.

People at the terminal need to be able to handle small, routine procedures.

Virtually no mechanical expertise is necessary. People must be able to follow written instructions, and that is about all.

6. What suggestions for improved operation would you make?

Make directions for operation simpler and less lengthy.

Make the picture fade slower after a question has been answered to allow the student to see why he missed the question if he did.

The hardware has simply got to be made more reliable. Some sort of service agreement with a computer company might help.

Operators of the terminals should be interested and receive training for the job.

There should be a refresher or orientation course for those involved with computer operations. A manual for operation--covering the very basics--should be available at all times at the terminals.

Put the terminals in the computer center to avoid the distance problem.

Put the terminals in a place where people have the necessary time to handle questions that arise.

We will eventually need more terminals if the demand continues to expand. For winter quarter, at least four instructors will be using this system, involving 30 to 40 different programs.

Instructions should be made simple enough that a student can bring the system into operation and take steps to overcome a malfunction.

There is a need for a simple documentation guide for students.

We should be able to simply sign in or sign off in a very abbreviated form.

--There ought to be a single number, possibly with a recording, to tell when "The computer is down".

The operation needs to get away from the role of a "service desk" into a more casual, library service type of operation.

We should take a look at alternative equipment systems and how feasible they are at this point.

We should continually monitor the quality of program operations, i.e. an ongoing, less formal evaluation.

7. How much operator time would you estimate is involved in:

a. Explaining to a student on his first time?

1-2 minutes: 2

3-5 minutes: 2

6 or more: 1

No estimate: 1

b. Bringing (the terminal) up into operation?

1-2 minutes: 2

3-5 minutes: 1

No estimate: 3

c. Operating when the student knows how?

0-1 minute: 3

No estimate: 3

d. In maintenance breakdowns:

This question had to be amended to ask how often, on the average, these were likely to occur.

Two per day, when many people using.

None in the past two months.

The trouble is that when a breakdown does occur, it is not uncommon to spend 15 minutes with one person getting it fixed. This poses a problem when other people are waiting for service.

Service on breakdowns has been considerably faster since last spring.

8. Additional comments:

If programs are written simply, there is little problem through equipment malfunctions.

Presently there is a program, "Coursewriter", which explains the commands necessary for computer operation to prospective faculty users. An additional drive program is available entitled "USU Teacher".

A DIARY OF COMPUTER TERMINAL ACTIVITIES

Kept By Library Staff Members (2) Monitoring
May 21-23, 1974

5/21/74	12:45 p.m.	All terminals went down. I called the Computer Center, and they said they had some trouble and that in 5 minutes I should bring all three terminals up again, from the first step.
	8:00 a.m.	Terminals were all down last evening - they kept repeating: "enter student #". They were o.k. this morning.
5/22/74	8:50 a.m.	I tried to bring up the terminals - the screen said "System problems, Down in 10 min. for 5 min. - Log-in denied at this time". Student left.
	9:30 a.m.	Terminals o.k. now.
	10:35 a.m.	All 3 keyboards locked - I waited 5-10 min. and called the computer specialist. He said wait 5 min. and try again.
	10:55 a.m.	The computer specialist called us to say the computer is down - hence all terminals down. He said I should call operations in about 1/2 hr. to see if the computer is working again. He also said I should keep checking the terminals to see if the polling light is on. The student left.
	12:00 noon	I have been checking, and the keyboards are all locked. I called the computer center and they have no idea when the computer will be up again. We are having all students sign up for new times.
	4:00 p.m.	All terminals still down.
5/23/74	10:10 a.m.	Terminal stopped on question 13 of a student's quiz. Recovery system didn't work; she had to begin again.
	12:40 p.m.	All terminals down - "keep repeating enter student #".
	1:30 p.m.	O.K. now
	3:30 p.m.	All terminals down - entire screen filled with designs and numbers. I called the computer specialist. He said to clear screens and try again. It didn't work. He said he would clear everything and we should wait a bit and bring them all up again, from the first step.

6/3/74	8:20 a.m.	I tried to bring up the terminals. The keyboards were locked. I called and waited for the computer specialist. I told him that the keyboards were locked and he said "Have you called operations?" He transferred me to operations, and again I waited. When they answered, I told them what was wrong, and they said they would fix it. I waited five minutes and checked again - now the keyboard light was polling. I started the procedure to bring them up; but when it came to the Usercode, it kept answering "No work file" on all the terminals. I called and waited for the computer specialist; he wasn't in. I waited for someone in operations - they said "we had an unscheduled cold start this morning, check with us again in about 15 minutes." I watched the screens and in a few minutes they printed "Please log-off for 2 hours for cold start". All students left.

PART II: STUDENTS

1. What previous use have you made of the CAI terminals in the Merrill Library?

   The responses to this item were the same for all students. All had been enrolled in Dr. Robert Mecham's class, Business Administration 360-2, during Spring Quarter, 1974, and had used the CAI terminals to take the required quizzes for the class.

2. What were your feelings about the system? (favorable, unfavorable, etc.)

   It was a new system for me, and I was a bit jittery. After the first two times, I was favorable toward it.

   There was a new experience, and I had some apprehensions. As soon as I became familiar with it, I was favorable.

   Favorable (2).

3. How long did it take you to get accustomed to using it?

   After the first time, it was easy. I had a good demonstration of how to do it.

   After two times, it was no problem.

   A few minutes was all it took me.

   After I'd gone through the program once, it was easy.

4. How much frustration did you encounter in using it?

   I ran into a couple of problems. One time it cut off when I was halfway through the program. Another time I got the same questions 2-3 times.

   It was annoying when the machine was down. For one stretch of the quarter, the machine was down at least 50 to 60 per cent of the time.

   It went well for me after the initial tries.

   I had a problem with giving the correct answer but being marked incorrect. Several other students reported similar problems.

   It was inconvenient when the terminal was down. You would plan your schedule and then have to make adjustments to come back.

5. Would you say that this type of instruction fits your style of learning?

Yes, I like the variety that the terminal gives. Also, the instant feedback is a help.

This was a new experience and fun for me. I like being presented with one question at a time and getting an instant answer.

The scheduling flexibility was helpful to me.

For me, this mode has more pressure on the student. It seemed that we had to speed up in answering.

6. What things do you particularly like about the system?

Convenience in scheduling.

Immediate feedback. That way you don't get a misconception.

The speed of operation.

Novelty. It has to be better than the same old paper and pencil quiz.

People are very helpful in showing you how to operate it.

The system is fast and you can work at your own speed.

7. What would you improve?

The program needed to be really debugged. Reliability was a problem.

Mechanical problems caused a couple of breakdowns. The operator taught me how to carry out instructions to solve the problem, however.

The level of difficulty of the questions should be standardized. With random choice operating, it seemed that some people got easy quizzes and others got tough ones.

A student should be able to go back to a previous question.

I could have used more time to see all the answers. After responding, it would be nice to see the correct answer and then compare it with the other choices, rather than having the picture fade immediately.

The beep after the question is distracting to me.

INTERVIEW QUESTIONNAIRE: POTENTIAL FACULTY USERS

1. How did you first become interested in using CAI at the Merrill Library?

I talked with someone in Instructional Development, then there was some interest generated in a workshop on campus dealing with criterion reference testing.

I had some experience at the University of Florida which got me interested. When I was at Clark University there was interest as well. At that time I was interested in combining a video test recording with computer assisted instruction. I wrote a proposal which I wanted us to set up--an audio visual tutorial system.

Roughly two years ago I heard about the arrangement through other members of the faculty in our department.

2. To what extent have you used it with your classes on campus?

I haven't used the system at the Merrill Library. We have developed a program at the exceptional child center which uses criterion reference testing. It is a tape program that lasts from 15 to 20 minutes.

I have written two programs which are available. I decided against using the system on the advice of the computer people. There was too much time and expense involved.

I had wanted to use a compatible language program with a printout and program branching capabilities. However, I decided to use the hot readers at the computer center because I needed a hard copy (printout) and needed to have a number of programs available.

3. Is it something you would recommend to other faculty members? How do you feel about this system?

Generally yes, if the program is applicable to their interest.

4. What features are helpful to you?

I want a positive learning experience for my students because I feel that it is important that they be familiar with this type of instruction. They get a good feeling when no mechanical difficulties are encountered.

5. What problems have you encountered?

The cost was judged prohibitive to our present system (a hand record keeping system). We use a point system and need to keep track of about 150 students.

When mechanical difficulties crop up, students don't learn and they pick up poor attitudes.

6. What additional uses could you see in your field?

Computer assisted instruction using the computer to teach could be useful but to this point has not been explored fully.

This teaching system makes a good group exercise. You have a group work at the computer terminal and talk about questions as they arise.

There ought to be some applications in computer classes. I am interested in an interactive program with simulation on four stages or levels: 1) a simple branching program for introduction, 2) interactive games such as the investment games, 3) simple statistical packages for correlation with actual data, and 4) an actual problem situation where the computer is used to solve a problem.

7. What suggestions would you have for improved usage?

We like using it in the library because of the location and later hours. It would help us to keep the library use open at least through 10 o'clock at night.

There needs to be a skilled person on hand to log the students on or to troubleshoot mechanical problems.

We could use a program that would give us a hard copy printout.

It seems to me the accessibility is the key to use in this program. The terminal should be put into the place where all can use it. It ought to be made available to the professors who want to use it, and we ought to encourage its use.

We need to remember that the time of students is valuable. We need to maximize the benefits of the computer in the minimum amount of time.

INTERVIEW QUESTIONNAIRE: FACULTY USERS

1. How did you first become interested in using CAI at the Merrill Library?

I was interested in frequent testing with immediate feedback, and I was having a problem with makeups. I got interested in a test scoring program through the computer and have gone ahead with that.

Through Instructional Development. When I first started work in this center I did not presently use the terminals at the Merrill Library.

We have presently quite a few computers in our own department. We have a portacon and a mini-computer. I became interested in the terminals in the library because we need more space and this could save us money.

We have a shortage of teletypes now. I think we can generate enough work to keep 12 terminals busy.

2. To what extent have you used it with your classes on campus?

So far we have two programs as supplementary to a statistics class. We are presently working to get a computer assisted instruction package available.

We use it for unit quizzes; testing students each quarter. I previously had two programs which allowed students to take exams at their own schedule with three re-takes possible. We had to phase this out due to unreliability of the system.

We have computer terminals in our own department which we use for testing programs in three classes--one using five quizzes, one using three quizzes, and one using six quizzes.

3. Is it something you would recommend to other faculty members? How do you feel about this system?

I am favorably disposed to CAI in general. It eliminates major problems in scheduling and monitoring quizzes.

Good. I would like to see 30 to 40 terminals here on campus. We might take a lesson from the Air Force Academy where hot readers and computer terminals are available to practically any student for practically any class.

I would recommend it to some faculty members; however, they do need to be able to take some frustration because the system does not always operate as anticipated.

I can't recommend it at this time since in our own case we had to discontinue use due to unreliability. We hope that this can be improved; and if the bugs were taken out, it has real potential.

4. What features are helpful to you?

We have developed our own testing program which gives the instructor his test score for each conceptual area. He can spot areas of strength and weakness quickly for each student.

It seems to me that teaching programs should have priority over testing programs. For one thing, testing is considerably cheaper using other means.

It eliminates the repetitive nature of record keeping and quiz administration. The time saving alone is very valuable.

In theory the system is really a good one. Students seem to like it.

5. What problems have you encountered?

At first we had a problem meshing our equipment with the system at the computer center. We had a lot of down time at first. I should say there has been a 10,000 per cent improvement since then. It works quite smoothly now.

It is difficult to provide instructions that are simple and that can be used by the student.

The programs have to be adapted to match with the central system.

There seems to be a problem in tying up library personnel for what is essentially a control function--test security.

Mainly our problems have been mechanical in nature. It seems like we are continually debugging. It seemed that the terminals kept breaking down.

6. Do you have a backup system? What is it?

Yes. If necessary, we use the teaching assistants to grade the printouts.

Yes, a hard copy system which we have had to use two or three times. The program is set up to simply print out the questions which the student can then respond to.

There is no need for a backup system. Repairs can be taken care of soon enough that it would be more trouble than it is worth.

Yes. The paper and pencil quizzes are available with the secretary like we had before we set up this CAI program.

7. What additional uses could you see in your field?

It seems to me it could be used for teaching if the course content is not changed much from quarter to quarter. We are pre-modualizing some courses.

There have been cost reductions in this kind of equipment in the same way that calculators have been reduced in price. It seems to me that they will become more available at lower prices in the future.

Some other people in our department could likely use this type of program.

There ought to be some way to use these facilities in research. Statistical work can be done in a similar manner that we now use a teletype system. The same computer terminal that is used to instruct can also be used for innovative work.

There is a way to use the computer terminal for monitoring--Computer Assisted Monitor (CAMS). This system can be used for keeping track of where a child is in the process of teaching. It gives the teacher immediate feedback and records data for research at the same time.

8. What suggestions would you have for improvement usage?

We have been able to get many of the bugs out of the program now, and it seems to me that there should be a summer training for the personnel who monitor the terminal. There should be someone with experience handling monitoring difficulties.

As soon as all the bugs are out of it, I want to go ahead with our program. Students need an orientation session. They ought to have about five practice sessions just to learn how it works.

There are quite a few options for instructors which as soon as we feel the programs are relisble should be presented to others. It seems to me that it is a good idea for a workshop. We need manpower available on the job with computer science training.

With slight modifications we could put a "multiplexer" unit to compress the messages. Line cost would remain the same, and speed would be increased greatly.

These terminals ought to be used for teaching rather than testing.

Why couldn't the people in the engineering department be used to set up internal telephone lines? The network is already there. They would simply have to string the lines. Why pay Bell Telephone for a line we could put in just as easily ourselves?

It seems to me that computers that are presently being used for administrative purposes should be made available for student instruction after hours.

As there are peak periods in administrative use, it should be possible to cut down the computer use by administration--possibly two hours in the morning and two hours in the afternoon--and then free up the lines for instructional use. I recognize there would be some monitoring problems, but I think these could be overcome easily.

We need someone to handle information systems on campus, a central planning agency instead of a haphazard proliferation of computer terminals.

One thing that is in the process of being implemented now is a general University budgeting account, rather than having to keep track of each account separately. When the job is less than five seconds, it can be billed to the central account. We feel that it increases the probability and makes people less reluctant to use the service. This should be available very soon.

APPENDIX C

An Explanation of Calculations of Costs And Benefits

Costs To MLLRP

I.A Initial Cost Of Terminals

CRT 45-1-2793	Purchased May, 1972	$2,582
CRT 45-1-2814	Purchased March, 1973	2,500
CRT 45-1-2815	Purchased March, 1973	2,500
	TOTAL	$7,582

(Source: Inventory Records)

1. With the rapid advance of computer technology, equipment is generally considered obsolete in three years and fuctional for eight years. Depreciation over five years represents a medium point. However, the alternative depreciation schedules at differing rates of interest and at different interest rates are as follows:

AMORTIZATION OF $7600

Monthly Payment

Period of Time	Interest Rate		
	6%	8%	10%
3 years	231.22	238.17	245.24
5 years	146.94	154.11	161.49
8 years	99.89	107.45	115.33

(Source: Federal Building and Loan Monthly Mortgage Calculator For Conventional And F.H.A. Loans, Boston, Massachusetts: Financial Publishing Company, 1973)

The interest rate chosen is purposely low. Any money obtained in 1972 would have been more expensive, probably considerably.

2. This figure represents interest foregone by having money invested. Once again, the low interest rate (6%) has been chosen. Money placed in a time deposit for five years at any insured bank would earn considerably more.

B. Cost of floor space: This could be calculated quite precisely as a proportion of the total area in the library. The estimate ($25) is considered conservative when the following considerations are included:

Depreciation of building costs
Cost of utilities: lights, heating, water, sewer
Janitorial service
Proportion of expense for stairs, lavatories
Rent of tables the terminals rest upon

This calculation was not made because the total area for CAI use (estimated 60 square feet) was not large enough to justify the effort involved.

II.A.1. This cost, monthly equipment cost, is paid directly to the telephone company and concerns the complex equipment involved in the polling operation. (Source: Telephone bill for Instructional Development)

2. This cost, paid to the Computer Center, covers the line cost. (Source: Computer bill for Instructional Development)

3. The telephone line for the terminal. (Source: Telephone bill for Instructional Development)

4. The maintenance cost for the terminals to date has been handled as needed, whenever terminals were not functioning. An effort was not made to go back and total all maintenance expenses to date, since maintenance was judged unsatisfactory. The present arrangement has been expensive.

Rates quoted by the sales representative at Beehive Medical Electronics, Inc., as the present price of service agreement through Sorbus or SEM was $350 per year per terminal. ($87.50 per month for three terminals) It is likely this could be reduced for three terminals together.

The figure used is based upon the specialist's estimation that this program did not require more than one or two hours per week.

The present programmer pay schedule is as follows:
Junior - $6/hour; Senior - $9/hour; Lead (Professional) - $11/hour
Assuming that the top category represents the programmer employed to write this program, a total cost of $1496 is calculated.

An additional $504 is added in to cover

1) Unanticipated programmer time
2) Tryout expense, debugging the program
3) Later expenditures to improve the program

B. Opportunity Cost: The same basis for calculation described for MLLRP.

C. Instructor time cost in program development, admittedly quite extensive in this case, is not computed for two reasons: (1) a mini grant from MLLRP for $300 was figured into the fixed costs and (2) it can be assumed that alternative quiz procedures would have to have been developed, probably quarter after quarter, which would be roughly equivalent to this program.

II.A. The monthly charge for computer use was the average of the previous five months billing for "on line storage" ($41.50). The division into "Data Storage" and "Computer Time In Use" was obtained by the instructor's estimate of $15 to $20 per month for data storage. The charge for computer use is seen to increase over a one-quarter period.

B. The cost of the computer specialist to troubleshoot has been covered by the Business Administration Department. It becomes a difficult item to estimate due to the sporatic nature of calls for service and because the need for these calls has fluctuated.

The estimate of $60 per month is based upon use of a qualified maintenance person in Logan. It covers labor, (at $12 per hour), parts, mileage, etc.

C. Personnel Cost: This estimate assumes minimal administration plus one-fifth time of the person monitoring (c.a. $3 per hour). Present hours of terminal accessability are as follows:

Monday-Thursday	8:00 a.m.-5:00 p.m., 7:00 p.m.-10:00 p.m.
Friday	8:00 a.m.-5:00 p.m.
Saturday	11:00 a.m.-9:00 p.m.
Sunday	1:00 p.m.-9:00 p.m.

Total hours: 75 per week. Figuring four weeks per month allows for holidays, schedule changes during quarter breaks, etc., comes to 300 hours per month. It is recognized that the work load will be heavier in some portions of the quarter and lighter in others. If weekend access to the terminals is not provided, cost is estimated at $232 per month.

Costs To Business Administration Department

I.A. Program development costs were estimated on the basis of programmer time involved by the technical specialist/troubleshooter as follows:

Writer Test	40 hours
Analysis	30 hours
Summary	25-30 hours
Paper Test	10 hours
Questionnaire	20 hours
Master File	3 hours
Files	1.5 hours
Class Files	1.5 hours
TOTAL	136 hours

APPENDIX D

A List Of Persons Interviewed Or Telephoned

In Conducting This Study

Bonnie Rae Anderson, student

Douglas Alder, Department Head, Honors Program

Sherry Berlage, Audio-Visual Assistant

Floyd J. Burnett, Assistant Professor, Computer Science

Cliff Craig, Instructor, History and Geography

Michael DeBloois, Associate Director, Instructional Development

Clark M. England, Coordinator, Auxiliary Accounting and Communication Services

Donna Forsburg, Accounts Controller, Computer Center

Katheryn Gardner, Assistant Professor, Instructional Media

LaDell C. Hoth, Assistant Professor, Instructional Media

Rex L. Hurst, Professor and Department Head, Applied Statistics and Computer Science

Bruce Israelson, student

Harold Lynch, Programmer, Computer Center

Robert C. Mecham, Associate Professor, Business Administration

Devere E. Miner, Inventory Clerk, Controller's Office

Rebecca S. Mitchell, Instructor, Home Economics and Consumer Education

Marlan D. Nelson, Associate Dean, Humanities, Arts, And Social Science

Max P. Peterson, Associate Professor and Associate Director MLLRP

Richard B. Powers, Associate Professor, Psychology

Darrell Sanders, Student

Tom Sawyer, Assistant Audio-Visual Librarian, MLLRP

William F. Sigler, Professor Emeritus, Wildlife Science

Robert H. Stocker, Assistant Professor, Business Education and Office Administration

Geneva Taylor, Student

Ron Thorkildson, Instructor, Computer Science, Business Administrator, Exceptional Child Center

R. Kent Wood, Assistant Professor, Instructional Media

Robert D. Woolley, Reference Librarian, MLLRP

Gary E. Wright, Loan Officer, Federal Building and Loan,
Salt Lake City, UT